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INLET COATING FOR GAS TURBINES

[0001] The present invention is directed to an abradable coating for gas turbines according to the definition of the species in claim 1.

[0002] Gas turbines, such as aircraft engines, typically include a plurality of rotating blades, as well as a plurality of stationary guide vanes, the blades rotating together with a rotor and the blades, as well as the guide vanes being enclosed by a fixed casing of the gas turbine. To boost the performance of an aircraft engine, it is vitally important that all components and subsystems be optimized. These also include the so-called sealing systems in aircraft engines. Maintaining a minimal gap between the rotating blades and the fixed casing of a high-pressure gas turbine is especially problematic in the context of aircraft engines. Namely, in high-pressure gas turbines, the highest absolute temperatures, as well as the greatest temperature gradients occur. This complicates the task of maintaining the gap between the rotating blades and the fixed casing of the compressor. This has to do, inter alia, with the fact that the shrouds, as are used for turbines, have been eliminated in the case of compressor blades.

[0003] As just mentioned, the blades in the compressor are not provided with a shroud. For that reason, the ends or tips of the rotating blades are subjected to a direct frictional contact with the fixed casing when rubbing into the same. Such a rubbing of the blade tips into the casing is caused by manufacturing tolerances produced when a minimal radial gap is set. Since the frictional contact of the tips of the rotating blades against the casing causes material to be ablated from the tips of the rotating blades, the gap can become undesirably enlarged over the entire periphery of the casing and rotor. To overcome this problem, it is already known from related art methods, to hardface the ends or tips of the rotating blades with a hard coating or with abrasive particles.

[0004] Another way to ensure that the tips of the rotating blades to not become worn and to provide an optimized sealing action between the ends or tips of the rotating blades and the fixed casing is to coat the casing with a so-called abradable coating. When material is ablated from an

abradable coating, the radial gap is not enlarged over the entire periphery, but rather, typically, only in a sickle shape. This makes it possible to avoid a decline in the engine performance. Casings having an abradable coating are generally known from the related art.

[0005] The EP 0765 951 B 1 describes an abradable coating for a gas turbine whose outer layer or top layer of the abradable coating, which is in contact with the tips of the blades, is produced from zirconium dioxide. Another abradable coating is known from the U.S. Patent 4,936,745.

[0006] Against this background, the object of the present invention is to devise a novel type of abradable coating for gas turbines.

[0007] This objective is achieved in that the abradable coating mentioned at the outset is further refined by the features set forth in the characterizing portion of claim 1.

[0008] The abradable coating according to the present invention for gas turbines is used for sealing a radial gap between a fixed casing of the gas turbine and rotating blades of the same. The abradable coating is applied to the casing. In accordance with the present invention, the abradable coating is at least single-layered, at least one outer layer of the abradable coating being fabricated from a material having a magnetoplumbite structure, preferably from lanthanum hexaaluminate. Accordingly, the present invention provides for the outer layer of the abradable coating, which first comes in contact with the rotating blades, to no longer be produced from zirconium dioxide, but preferably from lanthanum hexaaluminate.

[0009] In accordance with one advantageous embodiment of the present invention, the abradable coating is multi-layered, the outermost layer of the abradable coating, which is first able to be contacted by ends of the blades, being fabricated from lanthanum hexaaluminate. In this case, at least one additional, interior layer is disposed between the outer layer of lanthanum hexaaluminate and the casing. A first interior layer is formed as an adhesion-promoting layer; a second interior layer is produced from zirconium dioxide and is disposed between the first interior layer and the layer of lanthanum hexaaluminate. The second interior layer of zirconium dioxide is provided for increasing the useful life of the abradable coating.

[0010] Preferred embodiments of the present invention are derived from the dependent claims and from the following description.

[0011] The present invention is described in greater detail in the following on the basis of exemplary embodiments, without being limited thereto. Reference is made to the drawing, whose:

Figure 1 shows a very schematized representation of a blade of a gas turbine, together with a casing of the gas turbine and including an abradable coating applied to the housing; and

Figure 2 shows a very schematized representation of a blade of a gas turbine, together with a casing of the gas turbine and including an alternative abradable coating applied to the casing.

[0014] In a highly schematized view, Figure 1 illustrates a rotating blade 10 of a gas turbine, which rotates against a fixed casing 11, in the direction of arrow 12. An abradable coating 13 is disposed on casing 11.

[0015] Abradable coating 13 is used for sealing a radial gap between a tip, i.e., an end 14 of rotating blade 10 and fixed casing 11. The demands placed on such an abradable coating are very complex. Thus, the abradable coating must exhibit optimized wear characteristics, i.e., good chip formation and removability of the abraded material. In addition, there should be no transfer of material to rotating blades 10. Moreover, abradable coating 13 must exhibit a low frictional resistance. Abradable coating 13 must also not ignite in response to rotating blades 10 rubbing against it. Other demands placed on abradable coating 13 that are mentioned here exemplarily include erosion resistance, temperature resistance, resistance to heat exchange, and corrosion resistance to lubricants and sea water.

[0016] Figure 1 illustrates ends 14 of blades 10 coming in contact with abradable coating 13,

thereby releasing ablated material 15 in response to the centrifugal forces occurring during operation of the gas turbine and heating of the gas turbine. This pulverized ablated material 15 must be prevented from causing damage to rotating blades 10.

[0017] Along the lines of the present invention, abradable coating 13 is fabricated from a material having a magnetoplumbite structure; in the illustrated exemplary embodiment, from lanthanum hexaaluminate. The exemplary embodiment of Figure 1 relates to a single-layered abradable coating 13, the only layer of abradable coating 13 being produced from the lanthanum hexaaluminate and being directly deposited on casing 11. Accordingly, the present invention provides for lanthanum hexaaluminate to be used for fabricating the outer layer of abradable coatings, instead of the zirconium dioxide known from the related art.

[0018] Figure 2 illustrates a second exemplary embodiment of the present invention. Thus, Figure 2 shows, in turn, a rotating blade 16, which is rotating in the direction of arrow 17 relative to a fixed housing 18. An abradable coating 19 is again disposed on casing 18.

[0019] However, in contrast to the exemplary embodiment of Figure 1, abradable coating 19 of the exemplary embodiment according to Figure 2 is not single-layered, but rather multi-layered. An outer layer 20 of abradable coating 19, which first makes contact with blades 16, is again produced in accordance with the present invention from lanthanum hexaaluminate.

[0020] In addition, an interior layer 21 is provided between outer layer 20 and casing 18. Interior layer 21 is an adhesion-promoting layer, whose purpose is to improve the adhesion between casing 18 and outer layer 20. Adhesion-promoting interior layer 20 may be metallic.

[0021] An additional intermediate layer (not shown) of zirconium dioxide may be placed between the adhesion-promoting, interior layer 21 and outer layer 20 of lanthanum hexaaluminate. The purpose of this intermediate layer of zirconium dioxide is to improve the properties of the laminar structure, in particular, to increase its useful life.

[0022] It is noted here that three- or multi-layer abradable coatings along the lines of the present

invention may, of course, also be provided. In accordance with the present invention, however, the outer layer of a multi-layer abradable coating, which first comes in contact with the rotating blades of the gas turbine, should be produced from lanthanum hexaaluminate.

[0023] In the exemplary embodiment of Figure 2, a so-called barrier coating 23 is provided at end 22, i.e., at the tip of rotating blade 16. This barrier coating 23 is essentially produced by hardfacing of the blade tips. In the illustrated exemplary embodiment, barrier coating 23 encompasses a plurality of wedge-shaped elements 24, clearance spaces 25 being formed between adjacent elements 24 of barrier coating 23. In this respect, Figure 2 depicts a sealing system for a gas turbine, where an abradable coating 19 according to the present invention that is deposited on casing 18 of the gas turbine is combined with a barrier coating 23 disposed on the blade tips.

[0024] Underlying both exemplary embodiments of Figures 1 and 2 is the principle according to the present invention whereby an outer layer of an abradable coating, which comes in contact with the tips of the rotating blades, is produced from lanthanum hexaaluminate.

[0025] Especially beneficial properties are able to be achieved using an abradable coating of this kind. Thus, particularly good wear characteristics of the abradable coating are obtained. The other demands made of the abradable coating are also fulfilled or influenced in a beneficial way. For example, the temperature stability and useful life of the abradable coatings are improved.

[0026] Mention is made at this point that the abradable coating according to the present invention is deposited on the metallic surface of the casing using thermal spray-coating processes. The details pertaining to such thermal spray-coating processes are familiar to one skilled in the art whom this technical teaching concerns.